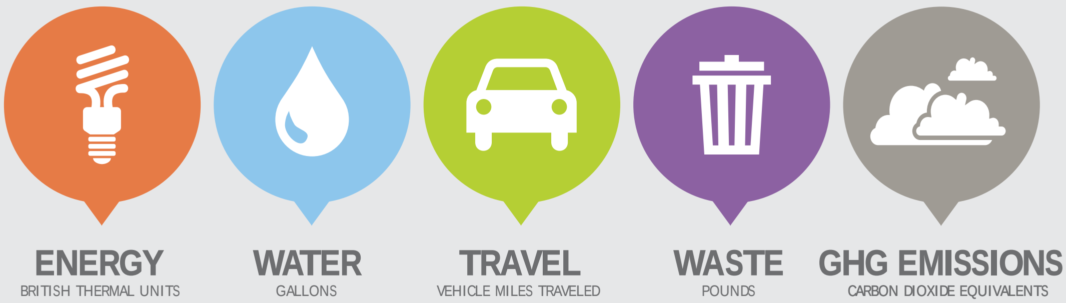
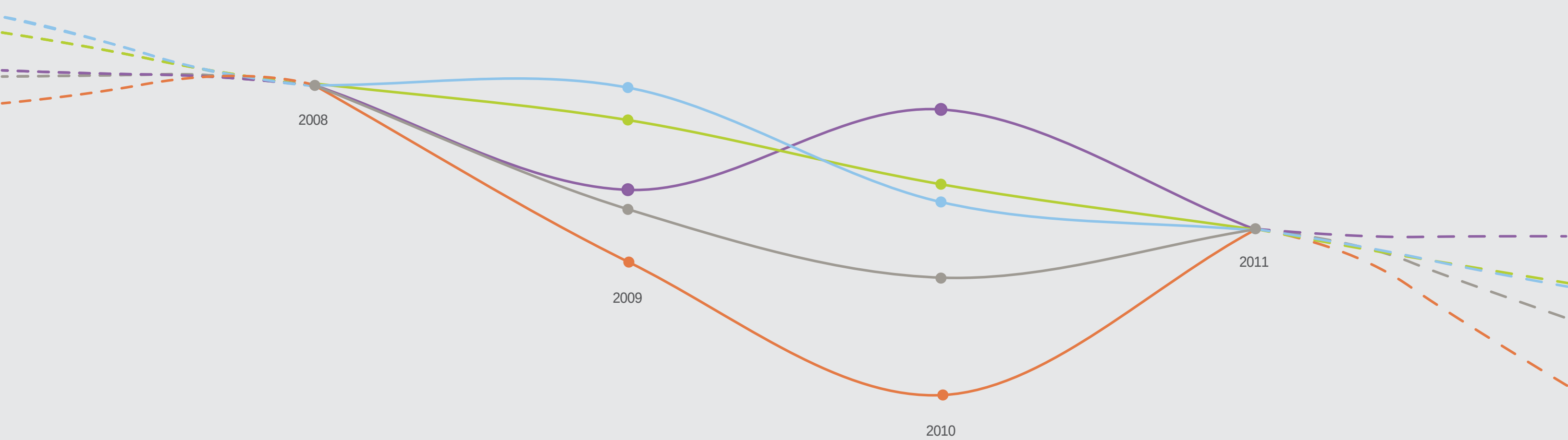
REGIONAL INDICATORS INITIATIVE
Measuring City-Wide Performance

An inventory of Energy, Potable Water, Travel, Waste, Greenhouse Gas Emissions and Costs for Twenty Minnesota Cities from 2008-2011





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Tables:

Participating Cities

Coon Rapids	Minnetonka
Duluth	Oakdale
Eagan	Richfield
Eden Prairie	Rochester
Edina	Shoreview
Falcon Heights	St. Anthony
Hopkins	St. Louis Park
Lake Elmo	St. Paul
Maplewood	White Bear Lake
Minneapolis	Woodbury

Executive Summary

Project Overview: The Regional Indicators Initiative (Initiative) measures annual performance metrics for approximately 20 Minnesota cities that are committed to increasing their overall efficiency and level of sustainability. The Initiative addresses two crucial components of planning for sustainability—carbon baseline assessments and annual indicators. The project collects the following four primary indicators for the four study years of 2008 to 2011generated through the activities of the people who live, work, learn, travel, visit, and recreate within each city's geographical boundaries:

- Energy: Total energy consumed for electricity production and the stationary combustion of natural gas and other fuels (coal, fuel oil, diesel, gasoline, propane) primarily for space heating.
- Water: Potable water consumed.
- Waste: Municipal solid waste managed via recycling, composting, combustion, and landfilling.
- Travel: On-road vehicle miles traveled.

Most of the indicators are expressed not only as annual totals, but are also broken down into residential and commercial/industrial uses, and are "normalized" in terms of per-capita, per-household, and per-job calculations that enable them to be compared over time with the data from peer cities.

The carbon baseline assessment (Assessment) prepared for each participating city measures the greenhouse gas (GHG) emissions associated with each of the above indicators as well as each city's share of airport-related GHG emissions, emissions associated with wastewater treatment, the associated energy consumption, and cost estimates (except airport share). The Initiative correlates these metrics with strategies to achieve savings in energy, water, vehicle miles traveled, and waste, and to reduce GHG emissions. Starting in Section 2 of this report, the focus is on the carbon baseline assessment portion of the Initiative. A description of the other aspects of this project can be found on the website that has been developed to communicate the findings of the Initiative, along with other written reports.

Purpose: As described by David Osborne and Ted Gaebler in their book, Reinventing Government (1992), "If you don't measure results, you can't tell success from failure. If you can't see success, you can't reward it. If you can't see failure, you can't correct it." Baseline assessments and indicators are useful. Planners need them, elected officials want them, and the future may see their development as a basic requirement of State and federal funding.

Measuring the energy aspects of human activities and the associated GHG emissions offers a unique way to compare the effectiveness of various energy and sustainability best management practices. Greenhouse gas emissions and energy serve as common denominators for the comparison of kilowatts of electricity, natural gas therms, and gallons of liquid fuels consumed; as well as vehicle miles traveled, tons of waste processed, and gallons of potable water treated and distributed.

The Initiative supports planning for sustainability by defining a baseline, tracking a trajectory, and measuring outcomes of sustainable strategies at a citywide scale. By producing annually comparable indicators for twenty Minnesota cities – including 27% of the state's population – the success of the State's GreenSteps Cities Program can be measured. Additionally, the Initiative will indicate progress toward meeting the State's energy efficiency and GHG reduction goals, as defined by the Minnesota Next Generation Energy Act of 2007.

Background: The Initiative is an outgrowth of the Minnesota Pollution Control Agency's GreenStep Cities Program. To achieve GreenStep certification, a city must meet minimum requirements and choose from 28 best management practices designed to improve the city's sustainability. While the program tracks which practices cities have adopted, it does not currently have a method of tracking how effective these strategies have been at "moving the needle" towards sustainability.

The project began with a pilot study that proved that the above four indicators of city sustainability can be measured, gathered, and analyzed annually in a reasonable period of time and at a relatively low cost. The Initiative was launched to continue this study at a larger scale, opening up the possibility to compare data across a range of Minnesota cities.

Partners: The Initiative is a collaborative project managed by LHB and ULI Minnesota. The carbon baseline portion of the Initiative is primarily the work of ORANGE Environmental, LLC. Funding for the Initiative comes from several sources—grant funds from the Minnesota Department of Commerce and the Minnesota Pollution Control Agency; pro bono services from LHB and ULI Minnesota; and a $2,500 fee paid by each participating city.

Participating cities: To date, the 20 following cities are participating in the Initiative (listed in order of population density within each category):

- **Central/stand-alone cities:** Minneapolis, St. Paul, Rochester, Duluth
- **Inner-ring suburbs:** Richfield, Hopkins, St. Louis Park, St. Anthony, Edina, Falcon Heights, Maplewood
- **Outer-ring suburbs:** White Bear Lake, Coon Rapids, Oakdale, Shoreview, Eagan, Eden Prairie, Minnetonka, Woodbury, Lake Elmo

The ICLEI Community Protocol: This report focuses on the GHG Assessment portion of the Initiative. The has been prepared consistent with the most applicable and current guides available; namely, the *U.S. ICLEI Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*, October 2012 (ICLEI Community Protocol), and the *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.1, May 2010 (Governmental Operations Protocol). Both of these documents were prepared by ICLEI – Local Governments for Sustainability (ICLEI), a United Nation's agency with a long and highly respected reputation for the development of such GHG assessment protocols.

The ICLEI Community Protocol addresses the important questions of what to measure (called Activities and Sources) and how to measure it. To address small Sources and Activities and allow their exclusion, it sets a minimum size threshold, called *de minimis*. The Protocol also describes methods to avoid double counting emissions for facilities that are shared among multiple communities.

Five Basic Emissions Generating Activities and Sources: Consistent with the ICLEI Community Protocol, the Assessments include data regarding the following required Activities and Sources:

- Use of purchased electricity
- Use of fuel in stationary applications
- Use of on-road motor vehicles
- Use of energy in the production and distribution of potable water and wastewater treatment
- Solid waste disposal

These Activities and Sources are required because 1) cities are the level of government that has the greatest authority and responsibility over the emissions-generating activity; 2) the data needed to estimate emissions are reasonably available; 3) the emissions associated with the Activity tend to be significant in magnitude; and 4) the Activity is important and common across U.S. communities.

Greenhouse Gas Terms: The greenhouse gases of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) are aggregated and reported as carbon dioxide equivalents (CO_2e), which is a commonly used unit that combines greenhouse gases of differing impact on the Earth's climate into one weighted unit. Greenhouse gas emissions are referred to herein as carbon dioxide equivalents (CO_2e) or used interchangeably as simply greenhouse gases (GHG).

Spreadsheets: The Assessment for each individual city includes 17 or more spreadsheets that disclose the data and data sources, conversion factors, and trend analyses particular to each city. The Table of Contents provides the list of spreadsheets and Section 4 of this report describes each one.

1.0. Introduction

1.1. Project Overview:

1.1. Project Overview: The Regional Indicators Initiative (Initiative) measures annual performance metrics for approximately 20 Minnesota cities that are committed to increasing their overall efficiency and level of sustainability. The Initiative addresses two crucial components of planning for sustainability—carbon baseline assessments and annual indicators. The project collects the following four primary indicators for the four study years of 2008 to 2011generated through the activities of the people who live, work, learn, travel, visit, and recreate within each city's geographical boundaries:

- Energy: Total energy consumed for electricity production and the stationary combustion of natural gas and other fuels (coal, fuel oil, diesel, gasoline, propane) primarily for space heating.
- Water: Potable water consumed.
- Waste: Municipal solid waste managed via recycling, composting, combustion, and landfilling.
- Travel: On-road vehicle miles traveled.

Most of the indicators are expressed not only as annual totals, but are also broken down into residential and commercial/industrial uses, and are "normalized" in terms of per-capita, per-household, and per-job calculations that enable them to be compared over time with the data from peer cities.

The carbon baseline assessment (Assessment) prepared for each participating city measures the greenhouse gas (GHG) emissions associated with each of the above indicators as well as each city's share of airport-related GHG emissions, emissions associated with wastewater treatment, the associated energy consumption, and cost estimates (except airport share). The Initiative correlates these metrics with strategies to achieve savings in energy, water, vehicle miles traveled, and waste, and to reduce GHG emissions.

Starting at Section 2.0, the remaining sections of this report. focus on the carbon baseline assessment portion of the Initiative. A description of the other aspects of this project can be found on the website that has been developed to communicate the findings of the Initiative, along with other written reports.

1.2. Purpose: As described by David Osborne and Ted Gaebler in their book, *Reinventing Government* (1992), "If you don't measure results, you can't tell success from failure. If you can't see success, you can't reward it. If you can't see failure, you can't correct it." Baseline assessments and indicators are useful. Planners need them, elected officials want them, and the future may see their development as a basic requirement of State and federal funding.

Measuring the energy aspects of human activities and the associated greenhouse gas emissions offers a unique way to compare the effectiveness of various energy and sustainability best management practices. Greenhouse gas emissions and energy (expressed as kBtus) serve as common denominators for the comparison of kilowatts of electricity, natural gas therms, and gallons of liquid fuels consumed; as well as vehicle miles traveled, tons of waste processed, and gallons of potable water distributed.

Recording these performance metrics is essential to promoting efficiency and sustainable change. The Initiative supports planning for sustainability by defining a baseline, tracking a trajectory, and measuring outcomes of sustainable strategies at a citywide scale. By producing annually comparable indicators for twenty Minnesota cities – including 27% of the state's population – the success of the State's GreenSteps Cities Program can be measured. Additionally, the Initiative will indicate progress toward meeting the State's energy efficiency and GHG reduction goals, as defined by the Minnesota Next Generation Energy Act of 2007.[1]

Along with providing statewide benefits, the Initiative is valuable to participating cities. Taking inventory of the resources consumed at the community level will:

- Highlight opportunities to save resources and money.
- Provide a baseline for estimating the effectiveness of sustainability measures.
- Enable comparison with future inventories and peer cities.
- Inform subsequent analyses, plans, and policy decisions by the cities and others.
- Improve the cities' competitiveness for federal and state funding opportunities that are targeted to cities that have taken steps to measure and improve their energy efficiency and reduce their carbon footprints.
- Assist in promoting public understanding of the cities' effects on climate change.
- Serve as a model for other regions.

1.3. Background: The Initiative is an outgrowth of the Minnesota Pollution Control Agency's GreenStep Cities Program. To achieve GreenStep certification, a city must meet minimum requirements and choose from 28 best management practices designed to improve the city's sustainability. While the program tracks which practices cities have adopted, it does not currently have a method of tracking how effective these strategies have been at "moving the needle" towards sustainability.

[1] In 2007, Minnesota approved one of the nation's most environmentally progressive energy laws. The Next Generation Energy Act required electric utilities to produce at least 25% of their total energy from new, renewable sources—wind, solar, hydro, biomass—by the year 2025. The law required Xcel Energy, the state's largest utility, to reach 30% by 2020. Currently, about 5% of the state's power comes from renewable sources. The act established nationally aggressive statewide greenhouse gas reduction goals (using 2005 as a baseline) of 15% by 2015, 30% by 2025, and 80% by 2050.

The desire to measure the impacts of sustainable practices led to a collaborative project, managed by LHB for ULI Minnesota.[2] This team developed a pilot to determine what citywide data can be collected annually to effectively measure progress towards sustainability. Three cities – St. Louis Park, Falcon Heights, and Edina – volunteered to release their performance data for the period of 2008-2010. The pilot study proved that the following four indicators of city sustainability can be measured, gathered, and analyzed annually in a reasonable period of time and at a relatively low cost: energy, water, vehicle miles travelled, and solid waste. The Regional Indicators Initiative was developed to continue this study at a larger scale, opening up the possibility to compare data across a range of Minnesota cities.

1.4. **Partners:** The Initiative is a collaborative project managed by LHB and ULI Minnesota. The carbon baseline portion of Initiative is primarily the work of ORANGE Environmental, LLC. Funding for the Initiative comes from several sources—grant funds from the Minnesota Department of Commerce and the Minnesota Pollution Control Agency; pro bono services from LHB and ULI Minnesota; and a $2,500 fee paid by each participating city.

1.5. **Participating cities:** To date, the 20 following cities are participating in the Initiative (listed in order of population density within each category):

- **Central/stand-alone cities:** Minneapolis, St. Paul, Rochester, Duluth
- **Inner-ring suburbs:** Richfield, Hopkins, St. Louis Park, St. Anthony, Edina, Falcon Heights, Maplewood
- **Outer-ring suburbs:** White Bear Lake, Coon Rapids, Oakdale, Shoreview, Eagan, Eden Prairie, Minnetonka, Woodbury, Lake Elmo

2.0. **Greenhouse Gas Assessment:** The remainder of this report focuses on the GHG Assessment portion of the Initiative. The carbon baseline assessments prepared for each participating city have been prepared consistent with the most applicable and current guides available; namely, the *U.S. ICLEI Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions,* October 2012 (ICLEI Community Protocol), and the *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories,* Version 1.1, May 2010 (Governmental

[2] From the LHB website "LHB is a multi-disciplinary engineering and architectural firm with 200 employees and offices throughout the Midwest. Founded in 1966, we serve a broad range of market sectors including Public Works and Structures, Pipeline, Industrial, Housing, Healthcare, Government, Education, and Commercial. LHB is dedicated to being environmentally responsible, reducing long term operating costs, and improving the quality of life for our clients."

From the ULI Minnesota website: "ULI Minnesota is a District Council of the Urban Land Institute, a 501(c) (3) nonprofit research and education organization supported by its members and sponsors. Founded in 1936, ULI has more than 30,000 members worldwide representing the full spectrum of land use and real estate development disciplines, including developers, builders, investors, architects, public officials, planners, real estate brokers, attorneys, engineers, financiers, academics and students. As the preeminent, multidisciplinary real estate forum, ULI facilitates the open exchange of ideas, information and experience among local, national and international industry leaders and policy makers dedicated to creating better places."

Operations Protocol). Both of these documents were prepared by ICLEI – Local Governments for Sustainability (ICLEI), a United Nation's agency with a long and highly respected reputation for the development of such assessment protocols.[3]

The ICLEI Community Protocol addresses the important questions of what to measure and how to measure it. These are no small matters. It has taken more than two decades of international collaboration to derive the best methods. The Protocol begins by clarifying the terms *Sources* and A*ctivities* and then divides emission sources and activities into two main categories, *Required* and *Optional*. To address small sources and allow their exclusion, the Protocol sets a minimum size threshold, called *de minimis* sources and activities. The ICLEI Community Protocol also describes methods to avoid double-counting emissions for facilities that are shared among multiple communities. Some carbon baseline assessments also include estimates of what is called *upstream* emissions or *life-cycle* emissions, which account for the embodied energy in materials. However, this potential source of emissions analysis has yet to be widely accepted for inclusion in GHG assessments because current methodologies result in questions regarding the double counting of emissions. Since it is not a Required Source or Activity according to the ICLEI Community Protocol, it is not included in the Initiative's assessments.

2.1. Sources and Activities: The following are the definitions of Sources and Activities from the ICLEI Community Protocol (p. 11): A Source is "Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere (e.g., combustion of gasoline in transportation; combustion of natural gas in electricity generation; methane emissions from a landfill)." An Activity is "The use of energy, materials, and/or services by members of the community that result in the creation of GHG emissions either directly (e.g., use of household furnaces and vehicles with internal combustion engines) or indirectly (e.g., use of electricity created through combustion of fossil fuels at a power plant, consumption of goods and services whose production, transport and/or disposal resulted in creation of GHG emissions)." While Sources are bound by the geography (the community boundary), Activities are not.

2.2. Required and Optional Emission Sources and Activities: The ICLEI Community Protocol divides the realm of possible emission Sources and Activities into two major groups: Five Basic Emissions Generating Activities (Required Activities), and Additional Community Emission Sources and Activities (Optional Sources and Activities). Section 4 below describes the

[3] ICLEI, along with its several international partner agencies, is considered the international leader in carbon baseline assessment protocols for local governments. According to its website, ICLEI – Local Governments for Sustainability is "an international association of almost 1,000 local governments worldwide and more than 250 in the US that have made commitments to sustainable development and climate protection. ICLEI, founded in 1990 as the International Council on Local Environmental Initiatives and now known officially as ICLEI – Local Governments for Sustainability, strives to advance solutions to global climate change through cumulative local action. ICLEI provides technical and policy assistance, software training, climate expertise, information services and peer networking to help members build capacity, share knowledge and implement sustainable development and climate protection at the local level."

various spreadsheets in the Assessments prepared for each city and identifies whether each emission category is a Required or an Optional Activity or Source.

2.2.1. Five Basic Emissions Generating Activities (Required Activities): To be consistent with the ICLEI Community Protocol, the following activities must be included in a communitywide assessment (Required Activities). These Activities are required at the city scale because 1) cities are the level of government with the greatest authority and responsibility over the emissions-generating activity;[4] 2) the data needed to estimate emissions are reasonably available; 3) the emissions associated with the Activity tend to be significant in magnitude; and 4) the Activity is important and common across U.S. communities. The following descriptions are adapted from the ICLEI Community Protocol:

- **Use of purchased electricity:** The Protocol requires the inclusion of power plant emissions associated with generating electricity used within the jurisdictional boundary of the community regardless of the location of the electricity generation facility. Local governments can often influence electricity use in local buildings through local building codes, financial incentives, minimum regulatory requirements, technical assistance, and other programs. The Assessments include all emissions from the consumption of electricity.
- **Use of fuel in stationary applications:** Each Assessment must include the combustion emissions associated with fuels used in stationary applications (e.g., natural gas and fuel oil used in furnaces and boilers) within the jurisdictional boundary of the community. Local governments can often influence use of fuels in stationary combustion applications through the same tools listed above for purchased electricity. All Assessments include emissions associated with natural gas combustion and major fuel oil and coal users.
- **Use of on-road motor vehicles:** Transportation fuels used by on-road motor vehicles comprise a major source of emissions. Local

[4] Numerous best practices are available to help cities both mitigate and adapt to climate change and conserve energy, for example:

- Adopt model sustainability plans, climate action plans, and peak oil action plans.
- Adopt model ordinances.
- Implement new urbanism, smart growth and smart shrinkage practices; implement transit-oriented development, complete streets programs, and travel demand management plans; and encourage traditional neighborhood design, mixed-use districts, and projects that meet the criteria of LEED for Neighborhood Development.
- Require high-performance building design, benchmarking, and building recommissioning, especially for public buildings.
- Encourage green power including renewable fuels, co-generation, district energy, and distributed generation.
- Green fleets.
- Require high-performance urban infrastructure.
- Foster sustainable urban forests and biodiversity corridors.

governments can influence transportation emissions by developing bicycle, pedestrian and public transit infrastructure, and by focusing new development along transit corridors, among other strategies. The Assessments include emissions associated with vehicle miles traveled (VMT).

- **Use of energy in the production and distribution of potable water and wastewater treatment:** The Protocol requires the collection of energy-related emissions associated with wastewater treatment and the production and delivery of potable water, regardless of the location of the water delivery and treatment infrastructure. Local governments can influence community water use through local building codes, promoting or providing incentives to foster conservation and efficiency, and through other programs and services.
  - **Potable water:** The Assessments include the amounts of potable water consumed within each city. While the electricity and natural gas consumed within each city to produce and distribute potable water are included in the citywide electricity and natural gas totals, they are not disaggregated for this analysis. A sampling analysis concluded that the emissions associated with these activities equal less than one percent of a community's total emissions, a level far below the *de minimis* threshold.
  - **Wastewater treatment:** The Assessments include each city's share of emissions associated with the treatment of its wastewater.
- **Solid waste disposal:** Although this Activity usually comprises a very small portion of a community's total emissions (generally less than 3%), the Protocol requires its inclusion because local governments can influence the amount of solid waste generated and sent to various disposal methods through their administration of garbage, recycling, and composting services. The Assessments account for end-of-life emissions (e.g., projected future methane emissions from landfills) associated with the disposal of waste generated by members of the community during the analysis year, regardless of disposal location or method (e.g., landfill, combustion, or biogenic treatment).

2.2.2. **Additional Community Emission Sources and Activities (Optional Sources and Activities):** The ICLEI Community Protocol recommends the inclusion of numerous optional emission sources and activities (Optional Sources and Activities) such as those associated with local rail travel, marine activities, and airplane travel. Expanding GHG inventory reporting to include Optional emission Sources and Activities is purely voluntary and is not required for a GHG emissions inventory report to be considered compliant with the Community Protocol. However, by including a broader set of emission-generating Activities and Sources in their reporting, a local government can provide a more complete picture of how the community contributes to GHG emissions.

The Assessments include one such Optional Activity—airplane travel—because for the 18 participating cities in the Twin Cities area, each city's share of the emissions from the Minneapolis Saint Paul International Airport exceeds the 5% *de minimis* threshold described below. To be consistent for all participating cities, the Assessments for the cities of Rochester and Duluth also include their shares of airport emissions (Rochester International and Duluth International airports), and the Assessments for the host cities of the Reliever Airports include these Sources (St. Paul for the St. Paul Downtown Airport, Lake Elmo for the Lake Elmo Airport, and Eden Prairie for the Flying Cloud Airport).

The Initiative does not include the optional activities associated with upstream emissions or embodied energy in materials, due to the previously mentioned risk of double counting.

2.3. **De Minimis Emission Threshold:** The ICLEI Community Protocol defines *de minimis* emissions as "a quantity of GHG emissions from any combination of sources and/or gases, which, when summed, equal less than five percent (5%) of community GHG emissions that are required to be included in the community GHG emissions report. These emission sources must be identified and described in the community GHG emissions report, but need not be quantified." This Assessment excludes several de minimis emission sources that are sometimes included in other assessments, such as emissions associated with marine and railroad operations, refrigerant and fire suppressants leakage, agricultural and livestock operations, and minor combustors of liquid fuels (e.g. fuel oil, propane, and diesel-powered heaters).[5, 6] Other assessments for Minnesota cities have shown that these excluded emission sources are not likely to exceed the *de minimis* threshold. Other assessments also estimate emissions associated with large sources of CO_2 such as the local production of concrete and fugitive emissions (primarily methane) associated with agricultural activities. There are no other known large sources of GHG emissions within the Project cities that are not already included.

2.4. **Shared Sources and the Risk of Double Counting:** Normally, all of the major emission Sources located within a community should be included in a GHG

[5] The Assessment does include major fuel oil users and portside emissions from the Port of Duluth. The GHG assessment prepared for Duluth in 2008 estimated the GHG emissions for rail and marine operations and both were de minimis sources: Rail (1% of total), marine (0.3% of total). Source: *City of Duluth Emissions Greenhouse Gas Inventory and Forecast 2008*, by Wenck Associates, Inc, March 2011.

[6] The Minnesota Pollution Control Agency provided 2001 data for liquid fuel and waste wood combustion for the 17 cities in the Initiative for which the MPCA had data. Only the data for Duluth was included in the Assessments. The GHG emissions associated with consumption levels for the other 16 cities were a fraction of 1% and therefore *de minimis* amounts.

assessment. However, certain Sources serve more than one community; for example, wastewater treatment plants, power plants, garbage processing plants, landfills, seaports, and airports. For these kinds of Sources, the Protocol provides methodologies to allocate the emissions among each community that uses the facility and to avoid double counting emissions.

This issue can be confusing. At its heart is geography. For emissions from shared facilities that are included in an assessment, the location of the facility is not a factor. For example, the assessment will include the emissions on a per-MWh-consumed basis from the electricity utility regardless of the location of the power plant. The same is true for emissions on a per-ton-incinerated basis for garbage incineration, a per-gallon-treated basis for wastewater treatment, and the prorated share of airport-based emissions (which are based on each city's share of residential on-road trips to the regional airport). However, geography does come into play for the host city of a shared facility and, therefore, the issue of double counting becomes a factor. Consistent with the ICLEI Community Protocol, the Assessments avoid double-counting emissions for the following "shared" Sources:

- **Power plants:** Because the GHG emissions associated with electricity consumption within Minneapolis already account for the natural gas consumption required to generate the city's share of electricity production at Xcel Energy's Riverside Generating Station, which is located within the city, total natural gas consumption at the plant is subtracted from the Minneapolis citywide total.[7] The same is true for Rochester Public Utility's two natural gas-fired power plants that are located within the City of Rochester (Cascade Creek and Silver Lake), and Minnesota Power's Hibbard steam and power plant located in Duluth.
- **Processing municipal solid waste:** The ICLEI Protocol describes methods to account for the GHG emission associated with processing municipal solid waste (MSW) in waste-to-energy garbage incinerators including the Hennepin Energy Resources Center (HERC) located in downtown Minneapolis and the Olmsted County Waste-to-Energy Facility (OWEF) in Rochester. Section 4.12. provides detail regarding this matter.
- **Wastewater treatment plants:** The Assessments account for each city's share of emissions associated with wastewater treatment. The Metropolitan Wastewater Treatment Plant (Metro Plant), located in St. Paul, treats sanitary sewer discharges from communities throughout the region. Since it is a "shared" facility, the natural gas and electricity consumed by the Metro Plant are subtracted from the citywide totals for St. Paul to avoid double counting. The same is true in the cases of Rochester and Duluth, which also host wastewater treatment plants.
- **Landfills:** Since the ICLEI Community Protocol classifies landfills as Required Sources, the Assessments account for the GHG emissions

[7] Although Xcel Energy's High Bridge Generating Station is located within the City of St. Paul, Xcel staff stated that the citywide natural gas consumption data the utility provided for the city does not include gas consumption at the High Bridge plant. Therefore, there is no double counting.

associated with the landfilling of municipal solid waste (MSW) on a per-ton basis for each city.[8]

- **District energy facilities:** There are 9 district energy systems that serve four of the participating cities in the Initiative. None of these systems serve multiple cities so they are not "shared" facilities. The Assessments account for all of the fossil fuels consumed by these facilities (natural gas, electricity, fuel oil, diesel, gasoline, and coal). Consistent with the ICLEI Community Protocol, the city totals do not count GHG emissions associated with biomass fuels (i.e. the waste wood burned by St. Paul District Energy, the University of Minnesota's Southeast Steam Plant, and plants in Duluth) because combustion only releases carbon that was sequestered during the growth of the plant matter so the net GHG effect is zero.
- **Airport share:** The Minneapolis St. Paul International (MSP) Airport serves an area far larger than the Twin Cities. Through the GHG inventory completed for the airport and trip share analyses prepared by the Metropolitan Council, the GHG emissions associated with aircraft operations and ground operations at the MSP Airport can be attributed to the cities in the region, as described in more detail below in Section 4.13.

3.0. Purpose, Definitions, and Data Sources for the Greenhouse Gas Assessment

3.1. Overall Purpose: The goal of the carbon baseline Assessment prepared for each city is to estimate the GHG emissions associated with the activities of the people who live, work, learn, travel, visit, and recreate within each city's geographical boundaries. Each is a citywide assessment that includes all pertinent and available data for the study years 2008 to 2011. Each Assessment must be transparent and able to be replicated, updated, and compared with other similar baseline assessments. None includes a separate accounting for emissions associated with specific city governmental operations; however, these emissions are included in the citywide data.

3.2. Greenhouse Gas Definitions: The greenhouse gases of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) are aggregated and reported as carbon dioxide equivalents (CO_2e), which is a commonly used unit that combines greenhouse gases of differing impact on the Earth's climate into one weighted unit. Greenhouse gas emissions are referred to herein as carbon dioxide equivalents (CO_2e) or interchangeably as simply greenhouse gases (GHG). They are expressed in metric tons (tonnes), which equal 1,000 kilograms, or 2,204.6 pounds. The use of the term CO_2 only refers to the individual greenhouse gas, carbon dioxide.

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[8] Olmsted County owns and operates the Kalamar sanitary landfill located outside the City of Rochester. The landfill does not utilize any form of methane capture. According to Rochester city staff, the landfill partly functions as an ash landfill and to accept overflow waste when the Olmsted County OWEF incinerator, which is located in the City, is not accepting waste. Currently, with three burners and enough solid waste to feed two of them, the County is excavating trash buried in previous years and burning it at its garbage incinerator.

3.3. **Data Sources, Methodologies, and Disclosure:** All of the sources of data for the Assessment are transparent, fully identified, verifiable, and reliable. They consist of city and county records and staff reports; utility records and reports to the Minnesota Public Utilities Commission; internationally recognized methodologies and published scientific papers regarding the calculation of GHG emissions; data from federal and State agencies (US Department of Transportation, US Environmental Protection Agency, Minnesota Department of Transportation, Minnesota Pollution Control Agency, and the Metropolitan Council of the Twin Cities); and other peer-reviewed, published sources. The following Section 4.0. and each of the spreadsheets contain information regarding the methodology used to estimate GHG emissions. The attached table, "Summary of Baseline Assessment Methodology for Estimating Greenhouse Gas Emissions and Energy," provides a summary listing of this information. To meet the requirements that the Assessments have full-disclosure and be replicable, all of the data used to estimate the GHG emissions and their energy equivalents are included in the spreadsheets.

3.4. **Sensitivity Analysis:** Virtually all of the data used to develop the Assessments were specific to each city or to the State of Minnesota, which helps to ensure their reliability and accuracy. However, there are a few important exceptions:

- **Vehicle miles traveled:** To derive the GHG emissions from vehicle use, the Assessment relies on the recent carbon baseline assessment prepared for the City of Minneapolis, the *City of Minneapolis Greenhouse Gas Inventories: A Geographic Assessment, City of Minneapolis*, 5/11/12 (Minneapolis GHG Inventory). This analysis relies on scientifically determined GHG emission factors and Minnesota data (refer to Section 4.8.3. for additional information). However, to derive an annual ratio of GHG emissions per vehicle mile traveled, the analysis relies on the national driving characteristics used in the US Department of Transportation's Mobile 5 computer model as well as other national data. This is necessary because comparable State data is not available. The use of national data as opposed to State data may introduce error.

- **Other minor sources:** The Assessments include estimates of GHG emissions from minor sources with varying degrees of accuracy. Solid waste management is the primary category because, as described in Section 4.8.4. below, municipal estimates were based on the best available data, which is only at the county level. Some of the data for other minor sources such as stationary combustion of stationary fuels were not available for all study years so it was assumed in some cases that the figures were relatively stable over all study years. Since these minor sources represent less than two percent of total emissions, it is reasonable to assume that the Assessments would retain a statistically acceptable degree of accuracy.

To test this accuracy, a sensitivity analysis was prepared for the Initiative (refer to Table 2 at the end of this report) that estimates the margin of error in the Assessments. It approaches the matter from two directions:

- **Worst-case scenario:** Since the GHG-per-VMT ratio accounts for a significant part of the total community-wide GHG calculation (about 27% overall in 2010), the sensitivity analysis first incorporated very high margins of error for all of the other major data sources in the Assessments to determine the maximum allowable margin of error for the GHG-per-VMT ratio. The attachment's fourth column shows these figures. The conclusion was ±15%. In other words, even if all of the other major data sources are off the mark by very large margins, the GHG-per-VMT ratio could still be off by up to ±15% and still yield a final GHG estimate that was within an acceptable ±10% of the actual number. The attachment's fifth column derives these figures. A margin of error greater than ±10% would be unacceptable.

- **Most likely case:** It is highly unlikely that all of the primary data sources have margins of error as calculated in the worst-case scenario. Rather, the data sources are reasonably reliable and the variation between the national fleet mix and the local fleet mix will probably not be substantial. This more reasonable case yields a likely margin of error that is about ±4%, a number well within the range of acceptability. The attachment's last column derives these figures.

4.0. Spreadsheet Descriptions: The following provides a brief description of the spreadsheets that comprise the Assessments for each individual city:

4.1. Initiative Summary: This spreadsheet is a brief stand-alone summary that includes all of the key citywide metrics along with demographic and weather information, costs, and comparisons of residential versus commercial/industrial consumption on per-capita, per-household and per-job bases. It also presents both the total GHG emissions, as described in Section 2.0. as well as a subtotal of GHG emissions from the four key metrics.

4.2. Detailed GHG Summary: This spreadsheet is a more detailed complement to the Initiative Summary. It brings together all of the major components of the GHG Assessment. All of the data come from the other spreadsheets, so sources for the data can be found in the source spreadsheets. It shows the percent changes from year to year to facilitate trend analysis. It also lists key indicators; namely, city population change and per-capita emissions, the change in electric utility CO_2 emission rate for electricity production (which is often a major factor in the change in electricity-related CO_2e emissions), and heating and cooling degree days (which are factors that affect building energy consumption for cooling and heating). It also includes building energy data normalized for weather.

4.3. **Costs:** Protocols for carbon baseline assessments do not include the estimate of costs associated with the sources and activities included in the assessment; however, this cost data has been calculated for this Initiative. Cost estimates focus on the retail costs of energy to the consumer. In the case of electricity, natural gas, and other stationary fuels, the estimates include the average retail costs for all of the consumption costs and related fees. For vehicle miles traveled, the Assessments include the average statewide costs for the fuel only, not the full costs of driving.[9] For waste management, the costs are statewide averages of the total retail service costs and fees for the various waste management methods.[10] For potable water production and distribution, only the energy costs are included (electricity and natural gas).The specific cost factors can be found in the Cost Factors spreadsheet for each city.

4.4. **Sector Shares:** The pie charts and bar charts provide snapshots of the relative share of GHG emissions, energy consumption, and costs in 2010 associated with the main sectors: electricity and natural gas consumption, vehicle miles traveled, airport share, and solid waste management. The bar chart compares the 2010 shares of GHG emissions, energy, and costs for the primary sectors of electricity, natural gas, and vehicle miles traveled; and the line charts illustrate change over time for this information.

4.5. **Energy:** This spreadsheet summarizes the GHG emissions associated with consumption of electricity, natural gas, major users of other fuels (fuel oil, coal, diesel, etc.) and shows the changes over time. These are Required Emission Sources. The spreadsheet also includes per-capita emission rates and energy consumption normalized for variable weather conditions. The Minneapolis GHG Inventory includes an additional spreadsheet that estimates the energy equivalents for the University of Minnesota's Southeast Steam Plant and major users of back-up fuels. The Duluth Assessment includes several additional sheets that estimate energy consumption and GHG emissions associated with the combustion of the various fuels used primarily to provide space heating (for both residential and commercial/industrial) in on-site furnaces and boilers and at the Duluth Steam Plant.

4.6. **Electricity:** Utility consumption data for all electricity customers within each city's borders are shown on this spreadsheet. Data are in two primary use categories: Residential and Commercial/Industrial.

4.6.1. **Definitions:** The following is the definition of a "residential customer" from Xcel Energy (other utilities use similar definitions): "A residential

[9] The average statewide fuel costs for 2008 to 2011 range from 13 to 20 cents per mile. This is in contrast to the estimates of the US Internal Revenue Service, which also take into account costs of maintenance, depreciation, insurance, and repair, and total about 55 cents per mile.

[10] Excluded are costs associated with household hazardous waste and problem materials ($225 per ton), source-separated organics ($220 per ton), and re-use and reduction efforts (which are assumed to be cost neutral).

customer is one using electric service for domestic purposes in space occupied as living quarters such as single private residences, duplex units, townhouse units, condominium units, apartment units, mobile homes, fraternity houses, sorority houses, and rooming houses. Domestic purposes or uses are domestic lighting, heating, cooking, and power service." Other consumption is in the Commercial/Industrial category and the small Public Street and Highway Lighting category.[11, 12]

4.6.2. Xcel Energy's "15/15 Rule:" In September 2012, it was learned that Xcel Energy had instituted a new policy in Minnesota called the "15/15 Rule" that applies when the company responds to a request for consumption data. According to Xcel, the "15/15 Rule" has been adopted by Xcel and several utilities across the country to help protect customers' data privacy when it comes to aggregated reports going to a third party. The "15/15 Rule" has two main aspects. It prevents the utility from disclosing consumption data to a third party for any customer group with less than 15 customers. For example, if there are only 14 Commercial & Industrial (C&I) customers in a group, the utility cannot release the aggregate consumption data to a third party. The Rule also prevents the utility from releasing data for a group where an individual customer's data makes up more than 15% of the aggregated group total. For example, if there were 100 C&I customers on the report with an aggregate total consumption of 1,000 kWh and one of those customer's total was 150 kWh, the utility must remove that customer's data from the report. The utility must then repeat the process to determine if there is a customer with consumption at 127.5 kWh or more (15% of the remaining 850 kWh).

Xcel stated that the consumption data for the following 11 of the project's 20 participating cities have data excluded because of the application of the 15/15 Rule (the four cities with excluded electricity and natural gas data are underlined for emphasis):

- Coon Rapids: Commercial/Industrial wind
- <u>Eagan</u>: Commercial/Industrial gas and electric
- Eden Prairie: Commercial/Industrial wind
- Edina: Commercial/Industrial wind

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[11] There can be a lot of "cross-over" between the residential and the commercial classifications in a single building. Consider this further clarification of Xcel Energy's methods of classification: "Apartment buildings often have individual electric meters for each unit, which are served on a residential rate and are included in the electric Residential class of service. They usually have another electric meter for laundry rooms and for common area lighting and cooling, served on a commercial electric rate and included in the Commercial class. These same apartment buildings often have one gas meter connected to a boiler and a water heater providing heat and hot water to all of the individual units. These meters are served on a commercial gas rate and are included in the gas Commercial class. However, if each unit has an individual gas meter serving only that unit's individual furnace and/or water heater, then it is served on a residential gas rate and included in the gas Residential class."

[12] In the case of the Duluth Steam Utility, this district energy system provides approximately 12% of its steam energy to buildings with multifamily units and mixed commercial/residential uses. The rest goes to non-residential uses. The spreadsheet file for the City of Duluth allocates the related emissions, energy, and costs accordingly.

- Falcon Heights: Commercial/Industrial wind and electric
- Maplewood: Commercial/Industrial gas and electric
- Minnetonka: Commercial/Industrial wind
- Oakdale – Residential wind and Commercial/Industrial wind and gas
- Richfield: Commercial/Industrial wind
- Shoreview: Residential and Commercial/Industrial wind
- St. Louis Park: Commercial/Industrial wind
- White Bear Lake: Residential and Commercial/Industrial wind

The excluded wind-based consumption is not likely to comprise a significant portion of overall consumption (probably less than 1%) and its exclusion has no effect on GHG emissions. The Assessments for these cities disclose the facts of this missing data. For the four cities where Xcel has withheld data for natural gas or non-wind-generated electricity due to the "15/15 Rule," the extent to which the disclosed data undercounts the actual data and for which years the rule was applied is not known. As such, the validity of this reported data is questionable.

4.7. **Natural Gas:** This spreadsheet includes the consumption data provided by natural gas suppliers. Consumption is categorized for Residential and for Commercial/Industrial uses using similar definitions as defined above for electricity. Refer to the above list of cities for which Xcel Energy has excluded gas consumption data per the 15/15 rule.

4.8. **Conversion Factors:** There are several components to the Conversion Factors spreadsheet:

4.8.1. **Conversion Factors for Utilities:** Table 1 provides the GHG emission factors and their references for electricity, natural gas, and other stationary fuel consumption. The conversion factors for electricity depend on the fuel mix used by each electricity supplier (i.e. the shares of coal, natural gas, biomass, wind, geothermal, and hydro) and the fuel mix for purchased electricity. The factors vary over time according to the particular power company. The electricity utilities provided annual emission factors for CO_2. Unlike electricity, the CO_2 emission factor for natural gas is relatively stable over time and among all suppliers. The table uses the conversion factors for the other primary greenhouse gases, N_2O and CH_4, to calculate the total CO_2 equivalent emission factor (CO_2e).

4.8.2. **Greenhouse Gas Emission Sources and Conversion Factors for Other Fuels:** Tables 2 and 3 work together to provide emission factors for a variety of fuels, their energy equivalents (in kBtu), and the tonnes of greenhouses gases per kBtu.

4.8.3. **Energy Equivalents of Vehicle Miles Traveled:** Table 4 relies on the recent carbon baseline assessment prepared for the City of Minneapolis, the *City of Minneapolis Greenhouse Gas Inventories: A Geographic Assessment, City of Minneapolis*, 5/11/12 (Minneapolis GHG Inventory). The Minneapolis GHG Inventory includes an analysis of the fuel consumption by type of fuel using the national fleet average fuel economy assumptions from the Energy Information Administration's *2012 Annual Energy Outlook* and the national vehicle fleet mix from the Clean Air Climate Protection (CACP) software from ICLEI--Local Governments for Sustainability.[13] The national fuel consumption estimates were modified to account for Minnesota's requirement that all gasoline and diesel fuels sold in the State since 2006 include 10% and 5% ethanol respectively, and from 2001-2005 to account for the use of 10% ethanol in gasoline only (B5 diesel was introduced State-wide in late 2005). This information enabled the estimation of the amount of energy associated with vehicle miles traveled in Minnesota.

4.8.4. **Conversion Factors for the Combustion of Municipal Solid Waste:** This final table, Table 5, addresses the two primary methods for processing municipal solid waste (MSW) via combustion. The Minneapolis GHG Inventory is the source of the data:

- **Mass burn incineration:** The table includes the total MSW processed at the Hennepin Energy Resources Center (HERC) and the associated GHG emissions. These data yield conversion factors to calculate GHG emissions on a per-ton basis for MSW processed at the facility. As described above, the table also includes the GHG emissions associated with the electricity and steam that are produced as valuable byproducts of the incineration. The same is true for the Olmsted County Waste to Energy Facility (OWEF) located in Rochester.

- **Refuse derived fuel:** The other major combustion method is to process MSW into refuse derived fuel (RDF) pellets that are burned in certified Xcel Energy power plants in Minnesota. Section 4.14 provides additional detail regarding RDF processing.

4.9. **Cost Factors:** As described above, the Project includes estimates of retail costs to the consumer of energy (electricity, natural gas, and other fuels), the costs of transportation fuels, the statewide average costs for the various waste management methodologies, and the energy costs (electricity and natural gas) associated with the production and distribution of potable water and each city's share of wastewater treatment. This spreadsheet provides the conversion factors for these cost estimates and the sources for the data.

[13] Refer to: http://www.icleiusa.org/action-center/tools/cacp-software.

4.10. **Seasonal Cooling and Heating Degree Days:** Because temperature has an effect on building energy consumption, this spreadsheet includes the normalization of the data pertaining to building energy consumption to better assess year-to-year changes and trends and allow peer-city comparisons. The “Base” figures, which are the 118-year averages of seasonal Heating Degree Days and Cooling Degree Days (HDD/CDD) for the Twin Cities, serve as the bases for calculating the “Normalizing Factor” for all cities participating in the Project. For example, if the actual seasonal cooling degree day is 10% higher than the Base, the portion of electricity consumption attributable to air conditioning is decreased by 10% to be normalized. It is assumed that 25% of all electricity consumption is for air conditioning. The remaining 75% is unaffected. Similarly for heating, if the seasonal CDD figure is 10% higher than the Base, the portion of total natural gas consumption associated with heating (which is assumed to be 80%) is reduced by 10% for normalization.

4.11. **On-Road Transportation:** The ICLEI Community Protocol defines on-road transportation as a Required Emission activity, and describes two recommended methods to estimate emissions: the “Demand Method” and the “Polygon Method.”[14] The latter method is used in this Assessment.

- **Translating Vehicle Miles Traveled into GHG Emissions:** The first step is to measure the number of vehicle miles traveled (VMT) within each city’s boundaries. Fortunately, this is the easy step because the Minnesota Department of Transportation (MNDOT) compiles accurate data regarding VMT on all of the roads in the State and aggregates them by cities and counties.[15] [16] The Minneapolis GHG Inventory includes annual fuel consumption by fuel type, which permitted the estimation of a GHG emission rate that accounted for the Minnesota fleet mix and the State’s biofuel concentrations, which are higher than the national average. This analysis yields a reasonably accurate estimate of the GHG emissions associated with vehicular travel.
- **Translating Vehicle Miles Traveled into Energy:** The Minneapolis GHG Inventory’s inclusion of annual fuel consumption by fuel type also permitted the estimation of an annual rate of energy consumed per 100

[14] Compared to Demand Method, the Polygon Method will somewhat over-predict VMT for communities with a disproportionately large amount of through traffic on major roads and under-predict for the opposite case. The Demand Method has similar drawbacks. The authors of the Minneapolis Assessment compared both approaches and chose to use the Polygon Method.

[15] Refer to: http://www.dot.state.mn.us/roadway/data/reports/vmt.html

[16] MNDOT traffic engineers use a variety of devices to collect traffic data including permanently installed loop detectors every half mile on metro area freeways, Automatic Traffic Recorders (ATRs) permanently installed in key locations throughout the state, and tube counts. The biggest share of the statewide counts comes from road tubes that are placed on the roadway for a 48-hour period. These counts are then adjusted to annual average daily traffic (AADT) by using factors that are derived from continuous counting sites. Historically, MNDOT has collected traffic data on all state roads on a two-year cycle, and on all county state aid roads, county roads, and municipal state aid streets on a two or four-year cycle. Once MNDOT engineers obtain the AADT for each segment of roadway, they can compute VMT by multiplying the AADT by the segment length. To get an AADT estimate for a year that a road was not counted, engineers use growth factors that are derived from ATRs and from other roads that are counted that year. For lower level roads that are not counted, engineers estimate the traffic volume.

million VMT as detailed above in the description of Table 4 of the Conversion Factors spreadsheet (Section 4.8.3.).

4.12. Vehicle Miles Traveled Charts: This spreadsheet includes three charts that help describe long-term changes in roadway transportation: total VMT, per-capita VMT, and per-capita GHG emissions associated with VMT.

4.13. Airports: How an airport is addressed depends on whether it is located within the community and how large it is.

4.13.1. Community Share of the Minneapolis St. Paul International Airport Emissions: The Minneapolis Saint Paul International (MSP) Airport is a major hub airport that serves an area larger than the Twin Cities region. It is contiguous to Minneapolis, St. Paul and the suburban cities of Bloomington, Eagan, Mendota Heights, and Richfield.[17] According to the ICLEI Community Protocol, it is classified as an Optional Activity, which means on this basis alone, it could be excluded from this Assessment. However, the MSP Airport emissions are included because, for the 18 participating cities in the region, each city's share of these emissions exceeds the *de minimis* threshold of 5%. In other words, when allocating the MSP Airport's emissions to a city in the region, the amount is greater than 5% of that city's total emissions. If it were less than 5%, the city's share of the Airport's emissions could be excluded from its Assessment. However, to retain a consistent methodology, airport share is included for all participating cities.

The Metropolitan Airport Commission conducted a GHG baseline assessment for the MSP Airport for the years 2005, 2007, and 2009.[18] The Minneapolis GHG Inventory relied on this assessment and used linear regression analysis to estimate GHG emissions for 2006, 2008, and 2010. Consistent with the ICLEI Community Protocol, each city's share of the MSP Airport's total emissions were assumed to be equal to the percent of residential home-based vehicle trips associated with the city that had either an origin or destination at the Airport. The Metropolitan Council calculated the "percent of city resident, home-based trips, as a percent of MSP total home-based trips" for 2010. This percentage was used for all study years because it was assumed that each city's share of vehicle trips would be relatively stable and that whatever variation did exist, it was well within the statistical significance of the Assessment.

4.13.2. Duluth and Rochester International Airports: Two other large airports serve cities participating in the Initiative: Duluth International Airport (DLH) and Rochester International Airport (RST). Data for the cities of

[17] For more information: http://www.mspairport.com/directions.aspx
[18] Refer to: *Greenhouse Gas Report: Metropolitan Airports Commission*, December 2010, http://www.mspairport.com/docs/about-msp/sustainability/MSP-2010-GHG-Report-Jan-2011.aspx.

Rochester and Duluth already capture ground-based emissions related to the operation of the airports including energy (electricity, natural gas, and fuel oil for buildings and facilities), vehicle miles traveled, municipal solid waste, and wastewater treatment. What remains are emissions related to aircraft operations. The Assessments for the cities include estimates that take into account aircraft fleet characteristics, average number of operations for each aircraft type from 2005 to 2011, typical fuel burn rates by aircraft type, estimated time of typical operation, and the GHG emission rate for aviation fuel.

According to the ICLEI Community Protocol, these airports would be classified as Optional Sources because their emissions occur within the jurisdictional boundary of the host cities. They are too small for their emissions to be treated as "shared" or "allocated," and the estimates show that emissions are *de minimis*. However, since the "airport share" emissions for the Minneapolis St. Paul Airport are not *de minimis*, emissions for these international airports are included in the respective city's assessments to maintain consistency of methodology among all 20 participating cities.

4.13.3. Reliever Airports: The Twin Cities include eight smaller airports with one of their roles being to relieve the MSP Airport of some of the private aircraft and cargo operations. Three of these airports are located within cities participating in the Initiative: The St. Paul Downtown Airport (Holman Field), the Flying Cloud Airport in Eden Prairie, and the Lake Elmo Airport in Lake Elmo.

Like the Rochester and Duluth airports, the ICLEI Community Protocol classifies these airports as Optional Sources because their emissions occur within the jurisdictional boundary of the host cities, and they are too small for their emissions to be treated as "shared" or "allocated." Again, since the "airport share" emissions for the Minneapolis St. Paul Airport are not *de minimis*, emissions for the reliever airports are included in the respective city's assessments to maintain consistency of methodology among all 20 participating cities.

4.14. Waste and Wastewater Treatment: The ICLEI Community Protocol classifies the emissions associated with the processing of solid waste as Required Activities. Although cities often gather selected data regarding city-sponsored residential recycling programs, counties are the primary compilers for comprehensive municipal solid waste (MSW) management data, which they report via Waste Certification Reports to the Minnesota Pollution Control Agency. In order to estimate waste management amounts at the municipal level, it is assumed that on a per-capita basis, city waste will be generated and managed at the same rates as those measured for the county.[19]

4.14.1. Emissions and Byproducts from Solid Waste Incineration: The Hennepin Energy Resources Center (HERC) is a waste-to-energy garbage incinerator located in downtown Minneapolis that processes municipal solid waste from communities throughout the region. Emissions come in two forms: biogenic and non-biogenic (or fossil-based emission).[20] Only the non-biogenic/fossil-based emissions are counted for the purposes of carbon baseline assessments per the ICLEI Community Protocol. The fossil-based emissions include all of the CH_4 and N_2O emissions. To develop conversion factors for incineration that yield GHG tonnes per ton of waste incinerated at the HERC facility, this Assessment relies on the GHG assessment prepared for the City of Minneapolis, which, in turn, relies on the GHG assessment prepared for the HERC facility. HERC is a "shared" facility, so its emissions are allocated on a per-ton basis for all of the cities that send waste to it for processing.

A second garbage incinerator, the Olmsted County Waste-to-Energy Facility (OWEF), serves Rochester. The facility produces power and sends the spent steam into the city's downtown district energy system.[21] As with the HERC facility, the per-ton GHG emission rates were derived using the measured GHG emissions for the study years.

- **Natural gas consumption:** To avoid double counting, the other fuel consumed at the two garbage incinerators, natural gas, is subtracted from the natural gas consumption totals for Minneapolis and Rochester.
- **Exported energy:** The two incinerators are essentially co-generation power plants that produce two products: electricity that is dispatched to the electrical grid, and steam that is piped into the two downtown district energy systems. To highlight the value of the exported electricity and steam, the waste spreadsheets disclose the equivalent per-ton-incinerated GHG emissions associated for waste generated within each city. Consistent with the ICLEI Protocol, the GHG emissions associated with these byproducts are not treated as "negative" emissions in the calculation of the GHG emission rate. In other words, the Assessments only disclose for

[19] The data for the City of Minneapolis is from the *City of Minneapolis Greenhouse Gas Inventories: A Geographic Assessment, City of Minneapolis*, 5/11/12.
[20] According to the ICLEI Community Protocol (Appendix E, p. 15), "The combustion of MSW components originally manufactured from fossil fuels (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) results in fossil based CO_2. The CO_2 emissions from combusting the biomass portion of MSW (e.g., yard waste, paper products) are biologic in origin and are reported separately."
[21] According to Rochester city staff, the chilled water and steam are actually more profitable for the plant than electricity. The steam is now being used to heat and cool the Rochester Community and Technical College campus and the downtown government, library and civic center campus.

informational purposes the GHG emissions attributable to the electricity and steam generated via the incineration of each city's portion of the waste stream.

4.14.2. Emissions and Byproducts from Refuse Derived Fuel Combustion: Two refuse derived fuel (RDF) facilities accept solid waste from cities within the region and process it into fuel pellets that are burned in certified Xcel Energy power plants in Minnesota (Elk River RDF plant and the Ramsey/Washington County RDF facility in Newport).[22] According to the EPA's Waste Reduction Model (WARM), processing MSW into RDF yields a more uniform fuel that has a higher heating value than that used for a mass burn facility (such as HERC). The EPA and ICLEI-USA have yet to derive a GHG emission rate that applies to MSW that has been processed and burned in this manner. As a default until an acceptable rate is available, the GHG emission rate for the HERC facility is used. The per-ton GHG equivalent of the electricity byproduct is assumed to be the same as for exported electricity for the HERC facility.

4.14.3. Emissions from Landfilling, Recycling, and Composting: ICLEI's Clean Air Climate Protection (CACP) Software provides estimates of GHG emissions associated with landfilling, which are primarily methane emissions from the anaerobic digestion of organic wastes. The CACP software accounts for this by incorporating the percent of the waste that is in landfills with methane recovery and the rate of recovery. The table in the Solid Waste spreadsheet accounts for that portion of the landfilled waste stream sent to landfills with no methane recovery by using a higher lifecycle-methane-production rate than waste sent to landfills with methane recovery. No GHG emissions are assumed to be directly associated with waste that is recycled or composted.

As stated above, the Olmsted County Kalamar Landfill is located within the City of Rochester. The Assessment for the City discloses the landfill's non-biogenic emissions, consistent with the Protocol.

4.14.4. Wastewater Treatment: Consistent with the ICLEI Protocol, the Assessments include each city's share of the GHG emissions from wastewater treatment facilities. The Metropolitan Council provided total emissions for the Metro Wastewater Treatment Plant in St. Paul and each participating city's percentage share of these emissions. The Rochester Water Reclamation Plant, located in Rochester, did not prepare a greenhouse gas assessment. Emission estimates for Rochester's wastewater are based upon the emission rate for the Metro Wastewater

[22] A fraction of the MSW collected in Dakota County is processed by the municipal incinerator in the City of Red Wing. Since the Assessments assume that a city's waste will be processed at the closest facility, the combusted portion of the City of Eagan's waste is assumed to be sent to the closer RDF facilities rather than the Red wing incinerator.

Treatment Plant multiplied by the known wastewater flow for the city. The same is true for the Western Lake Superior Wastewater Treatment Plant in Duluth.

4.15. **Solid Waste Composition:** The CACP software takes into account the composition of the MSW. This spreadsheet includes the results of two waste composition studies for comparison purposes and to confirm the appropriateness of the use of the Minnesota Pollution Control Agency study for this analysis.

4.16. **Demographics:** Many of the spreadsheets rely on per-capita, per-household, and per-job calculations. This spreadsheet provides population, household, and employment data for each city; and county and regional populations.

4.17. **Precipitation and Potable Water:** The Assessments include data regarding annual precipitation and the distribution of potable water within the city.[23] As stated above, the ICLEI Community Protocol requires the collection of emissions associated with energy used in delivery of water used within the jurisdictional boundary of the community, regardless of the location of the water delivery infrastructure. Carbon baseline assessments prepared for the cities of Minneapolis and Burnsville indicate that the energy (electricity and natural gas) needed to treat and distribute potable water constitutes less than 1% of the total GHG emissions for each city (well under the 5% de minimis threshold). While the Assessments do include the electricity and natural gas consumption data associated with the distribution of potable water, the data are not disaggregated from the citywide consumption data for each city.

4.18. **Summary of Baseline Assessment Methodology for Estimating Greenhouse Gas Emissions and Energy:** The intent of the following table is to provide a convenient summary that categorizes the various emission sources, lists their classifications per the ICLEI Community Protocol, and identifies the primary data sources. The table also includes the data resources used to calculate the energy value of the various emission sources and their costs.

Tables

1. Summary of Baseline Assessment Methodology for Estimating Greenhouse Gas Emissions, Energy, Costs, and Forecasts
2. Sensitivity Analysis

[23] Each city provided its own potable water distribution data.

Summary of Baseline Assessment Methodology for Estimating Greenhouse Gas Emissions, Energy, Costs, and Forecasts				
Emission Source, Activity, and Classification		**Applicability**	**Source of Data**	**Estimation Methodology**
Electricity Consumption				
	Required Activity	All cities	A, B	MWh times conversion factors and energy content
	Shared Source [1]	Host city Minneapolis: Xcel Energy's Riverside Generating Station	A, C	Natural gas consumption subtracted from citywide total to avoid double counting
	Shared Source [1]	Host city St. Paul: Xcel Energy's High Bridge Generating Station	A	Natural gas consumption at the plant is not included in the citywide totals. No risk of double counting
	Not a shared Source: Virtually 100% of consumption within city limits.	Host City Rochester: Rochester Public Utility power plants: Cascade Creek (natural gas) and Silver Lake (coal and natural gas)	A	MWh times conversion factors and energy content
			B	Natural gas consumption subtracted from citywide total to avoid double counting.
	Not a shared Source: Virtually 100% of consumption within city limits.	Host city Duluth: Minnesota Power's Hibbard steam and power plant provides electricity and steam to the downtown district energy system	A, B	GHG emissions from natural gas and coal consumption subtracted from citywide total to avoid double counting. For coal-based energy, short tons of coal consumed times conversion factors.
Natural Gas Consumption, Required Activity		All cities	A, B	Therms times conversion factors and energy content
Fuel Oil Consumption, Optional Activity		Cities that host major fuel oil users	B, D	Gallons times conversion factors and energy content
Energy Consumption from District Energy Facilities, Required Activity				The Assessment accounts for all fossil fuels consumed by district energy facilities (natural gas, electricity, fuel oil, and coal).
	There are 9 district energy systems that serve 4 of the participating cities. None of these systems serves multiple cities so they are not "shared" facilities. [2]		A, B, D	
		Host city Duluth: Duluth Steam Plant provides steam to the downtown district energy system. It burns natural gas and coal.	A, B	The natural gas consumption is captured in Comfort Systems data. For coal consumption: Tons of coal times emission factor. For coal-based energy, short tons of coal consumed times conversion factors.
Vehicle Miles Traveled, Required Activity		All cities	E	VMT by roadway by city
			B, D, E, F	Calculation includes VMT, national vehicle fleet mix, average fuel economy statistics, Minnesota fuel characteristics
Airports Emissions, Optional Source				

	Minneapolis Saint Paul International Airport; Optional Source (but exceeds de minimis threshold that would permit exclusion)	Cities in the Twin Cities	H	Total MSP Airport emissions in report
			I	Met Council analysis enabled allocation of MSP Airport emissions to each city in region.
	Rochester International Airport; Optional Source (de minimis)	Host city Rochester	B, N, P	Emissions are de minimis but since the "airport share" emissions for the Minneapolis St. Paul Airport are not de minimis, they are included to maintain a consistent methodology for all participating cities. Methodology: Average operations for each aircraft type from 2005 to 2011, times typical fuel burn rates by aircraft type, times estimated time of typical operation, times GHG emission rate for aviation fuel.
	Duluth International Airport; Optional Source (de minimis)	Host city Duluth		
	Twin Cities Reliever Airports; Optional Sources (de minimis)	Host cities: St. Paul (St. Paul Downtown), Eden Prairie (Flying Cloud), Lake Elmo (Lake Elmo)	B, O, P	
Rail Operations; Optional Source		Duluth; the city with the most intense rail concentration	M	Emissions are less than 5% de minimis threshold of city total; therefore, not included [4, 6]
Seaport; Optional Source		Host city Duluth: Duluth Port Authority	M	Emissions are less than 5% de minimis threshold of city total; therefore, not included [4, 6]
Solid Waste Management; Required Activity		All cities	J	County per-ton, waste management methods apply to each city on a per-capita basis to estimate waste amounts by processing methods (combustion, landfilling, recycling)
	Combustion	Hennepin Energy Resources Center (HERC) users	C	Calculate GHG emission rate (tonnes of GHG per ton of waste) times tons of waste for each city
	Byproducts of combustion			Per-ton GHG value of electricity and steam disclosed but not counted in emissions totals
	Shared Source [1]	Host city Minneapolis: HERC facility	C	Subtract 100% natural gas from citywide total to avoid double counting.
	Combustion	Users of Red Wing garbage incinerator	C	Assume same GHG emission rate as for HERC
	Byproducts of combustion			
	Combustion	Users of Washington/Ramsey and Elk River refuse derived fuel (RDF) facilities	C	ICLEI Community Protocol does not yet have a GHG emission rate for RDF. Assume same GHG emission rate as for HERC and same electricity production rate per ton of waste as for HERC.
	Byproducts of combustion			
	Combustion	Users of Olmsted Waste to Energy Facility (OWEF)	K	Calculate GHG emission rate (tonnes of GHG per ton of waste) times tons of waste for city

	Byproducts of combustion			Per-ton GHG value of electricity and steam
	Shared Source [1]	Host city Rochester: OWEF		Subtract 100% natural gas from citywide total to avoid double counting.
	Landfilling	All cities	F	CACP software emission rates for landfilled waste times methane recovery rate times tons landfilled.
	Shared Source [1]	Host city Rochester: Olmsted County/Kalamar Landfill (no methane recovery)	K, R	Disclose non-biogenic emissions.
Wastewater Treatment; Required Activity		All cities		For cities in Twin Cities region, city share of total emissions from the Metro Wastewater Treatment Plant. Since the plants in Rochester and Duluth do not have a GHG assessments, the per-gallon emissions rate for the Metro Plant is a surrogate for both cities.
	Shared Source [1]	Host city St. Paul: Metro Wastewater Treatment Plant	L	Subtract electricity and natural gas consumption from citywide totals. Electricity production for on-site use only.
	Not a shared Source [5]	Host city Duluth: Western Lake Superior Sanitary District Duluth plant	A, R	Subtract consumption of natural gas and fuel oil from citywide totals. Disclose electricity production.
	Not a shared Source. More than 99% of users are within the city.	Host City Rochester: Rochester Public Utility	A, R	Subtract electricity and natural gas consumption from citywide totals. Electricity production for on-site use only.
Greenhouse Gas Emission Forecasts [7]		All	Q	The Minnesota GHG data was used to generate a base case scenario for 2005 for each city and then project business-as-usual forecasts and a target forecasts for 2020 and 2030 for energy, VMT, and municipal solid waste.
Cost estimations: [8]		All cities		
	Electricity		S	Electricity consumption by customer class times the average cost per MWh.
	Natural gas		S	Natural gas consumption by customer class times the average cost per therm.
	Vehicle miles traveled		T	Average fuel prices by type of fuel for 2008 to 2011 times total statewide consumption by fuel type, divided by total VMT yielded an average fuel cost per VMT per year.

	Solid waste management		U	Statewide average per-ton costs per waste management method times tons managed.
	Potable Water Production and Distribution		V	Gallons of water times the energy cost factor (electricity and natural gas)
Forecasts:		All cities	W, X	The State forecasts include 2 future GHG emission scenarios for energy, travel, and waste: Business as usual and a reduction target based on the Minnesota Next Generation Energy Act. These statewide forecast methods are applied to each city
Excluded emission sources (de minimis): [4]				
	Back-up energy and on-site home heating: Minor users of fuel oil, diesel for back-up generators, propane, compressed natural gas, etc.			
	Rail and marine vessel operations: The baseline assessment prepared for Minneapolis (Source C) calculated the GHG emissions associated with rail and marine operations within Minneapolis to equal less than 1% of total emissions. The same is true for Duluth per source M.			
	Upstream emissions and imbedded energy in materials: This potential source of emissions analysis has yet to be widely accepted for inclusion in GHG assessments and it is not a Required Source according to the ICLEI Community Protocol. Current methodologies result in questions regarding the double counting of emissions.			
Information Sources:				
A	Utility data			
B	*International Local Government Greenhouse Gas Emissions Analysis Protocol*, Version 1.1, May 2010, ICLEI--Local Governments for Sustainability, et al.			
C	*City of Minneapolis Greenhouse Gas Inventories: A Geographic Inventory*, City of Minneapolis, 5/11/12.			
D	Fuel oil consumption data for major users, Minnesota Pollution Control Agency, and the USEPA's GHG Mandatory Reporting Rule: http://www.epa.gov/climatechange/emissions/ghgdata/index.html			
E	Minnesota Department of Transportation			
F	Clean Air Climate Protection software from ICLEI--Local Governments for Sustainability, et al.			
G	Federal Energy Information Administration's *2012 Annual Energy Outlook.*			
H	*Greenhouse Gas Report: Metropolitan Airports Commission*, December 2010.			
I	The Metropolitan Council calculated the "percent of city resident, home-based trips, as a percent of MSP total home-based trips" for 2010. Each city's share of vehicle trips was assumed to be relatively stable and therefore used for all study years.			
J	MPCA SCORE Reports and county Waste Certification reports			
K	U.S. EPA's Final Mandatory Reporting of Greenhouse Gases Rule (MRR): http://ghgdata.epa.gov/ghgp/main.do			
L	Metropolitan Council Environmental Services data for the Metro Wastewater Treatment Plant.			
M	*City of Duluth Greenhouse Gas Inventory and Forecast 2008*, Wencke Associates, Inc, March 2011.			
N	US Federal Aviation Administration Air Traffic Activity System (ATADS); ATADS Report - http://aspm.faa.gov/opsnet/sys/opsnet-server-x.asp			

O	Activity Forecasts Technical Report, Appendix A, HNTB Corporation. http://metroairports.org/MAC/appdocs/meetings/pde/agenda/pde_a_1151/Appendix_A_AviationActivityForecast_072712.pdf
P	Numerous sources were used to estimate the average fuel-burn rates by aircraft type for a typical operation.
Q	*Final Minnesota Greenhouse Gas Inventory and Reference Case Projections 1990-2025*, Center for Climate Strategies, March 2008
R	*U.S. ICLEI Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*, October 2012
S	Xcel Energy provided average costs for NSP Minnesota customers for 2008 to 2011 for electricity and natural gas. For utilities other than NSP Minnesota, average cost per customer for electricity and natural gas in Minnesota from 2008 to 2011 is from the US Energy Information Administration, http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_smn_a.htm.
T	Fuel consumption by type of fuel and by year came from the *City of Minneapolis Greenhouse Gas Inventories: A Geographic Inventory*, City of Minneapolis, 5/11/12 (Source C). Average fuel prices are from the following sources: Weekly Retail Gasoline and Diesel Prices, Minnesota (all grades). Source: US Energy Information Agency, http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_smn_a.htm. Clean Cities Alternative Fuel Price Report, US Department of Energy, http://www.afdc.energy.gov/publications/search/keyword/?q=alternative%20fuel%20price%20report. Midwest #2 Diesel Retail Prices: Source: US Energy Information Agency, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emd_epd2d_pte_r20_dpg&f=a
U	The source for statewide average per-ton costs by waste management method (recycling, combustion, and landfilling) is from “2008 Payments and Spending for Integrated Solid Waste Management (ISWM) in Minnesota,” Sig Scheurle, Minnesota Pollution Control Agency.
V	Cost estimates for the production and distribution of potable water include the energy costs. The electrical consumption rate is based on the collective experience of numerous US cities as reported in the Climate and Air Pollution Planning Assistant, by ICLEI Local Governments for Sustainability USA, "Low maintenance landscaping" model. Baseline analyses for other cities indicate that natural gas consumption costs related to the production and distribution of potable water constitute about 8% of total costs. Therefore, the electricity costs are divided by 0.92 to account for the natural gas costs.
W	*Final Minnesota Greenhouse Gas Inventory and Reference Case Projections 1990-2025*, Center for Climate Strategies, March 2008
X	Residential water consumption targets based on the water saving strategies in: Vickers, Amy. 2002. *Handbook of Water Use and Conservation*. WaterPlow Press. Amherst, MA.).
Notes:	
1	Consistent with the *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions*, October 2012, ICLEI—Local Governments for Sustainability USA (ICLEI Community Protocol), the emissions from certain facilities with region-wide user bases (e.g. power plants, solid waste and wastewater treatment facilities, and airports) are considered shared facilities and their emissions are allocated among the users of the facilities. To avoid double counting, utility-based energy (electricity and natural gas) for these facilities are subtracted from the totals of the host cities.
2	Per the ICLEI Community Protocol, the city totals do not count GHG emissions associated with biomass fuels, i.e. the waste wood burned by St. Paul District Energy and the University of Minnesota’s Southeast Steam Plant.
3	The Duluth and Rochester international airports are located within their respective cities. They are not considered shared facilities that have significant region-wide user bases for this analysis for the following reasons: 1) The majority of the airport users have a direct economic and geographic relationship to their respective host cities. 2) They are small compared to the Minneapolis St. Paul Airport. 3) Emission estimates are de minimis for their respective host cities. This same argument holds for the Twin Cities reliever airports.

4	According to the *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions*, October 2012, ICLEI—Local Governments for Sustainability USA, de minimis emissions are "a quantity of GHG emissions from any combination of sources and/or gases, which, when summed, equal less than five percent (5%) of community GHG emissions that are required to be included in the community GHG emissions report." De minimis emissions are not required to be reported.
5	The Western Lake Superior Sanitation District operates a wastewater treatment plant in Duluth. It currently treats wastewater from only one subdivision outside the City limits, Chester Heights with about 90 households (about 0.2% of total City households).
6	The GHG assessment prepared for Duluth in 2008 (Source M) estimated the GHG emissions for rail and marine operations and both were de minimis sources: Rail (1% of total), marine (0.3% of total).
7	The Minnesota data includes actual GHG emissions by major categories (energy, travel, and waste) for the State and 2 future scenarios: Business as usual and a reduction target based on the Minnesota Next Generation Energy Act, which established statewide goals of 15% by 2015, 30% by 2025, and 80% by 2050. It is assumed that each city forecast matches the State's percentage reduction projections.
8	Cost estimations focus on the costs of energy to the consumer. In the case of electricity and natural gas, the estimates include the average retail costs for all of the consumption costs and related fees. For vehicle miles traveled, it includes the average statewide costs for the fuel only, not the full costs of driving. For waste management, the costs are statewide averages of the total retail service costs and fees for the various waste management methods. Excluded are costs associated with household hazardous waste and problem materials ($225 per ton), source-separated organics ($220 per ton), and re-use and reduction efforts (which are assumed to be cost neutral). For potable water production and distribution and wastewater treatment, only the energy costs are included (electricity and natural gas).

Sensitivity Analysis

Updated: 1/7/13

Assessment Components	Data Sources	Reliability	Maximum Range of Component Accuracy (±%)	Component Percent of Total GHG	Maximum Range of Inventory Accuracy (±%)
Electricity and natural gas	Energy consumption from utilities	Extremely accurate data via individual meters.	5%	65%	3.3%
	GHG emission factors from utilities	Required by law to measure and report accurately.			
	Global warming potentials of GHG emissions	Extremely accurate data via scientific measurements.			
Other fuels (fuel oil, diesel, coal,	MN Pollution Control Agency, University of Minnesota	Extremely accurate data via individual meters as reported to the MPCA and provided by the U of M.	n/a	n/a	negligible
GHG from VMT	MNDOT measured and estimated VMT	State-verified data dating back more than 2 decades.	5%	27%	1.3%
	USDOT Mobile 5 computer model, MN Department of Transportation, and scientifically determined GHG emission factors	Relies on national driving characteristics and fleet mix and the Minnesota fuel mix.	15%		3.9%
GHG from share of airport emissions	Airport data from multiple sources (refer to Methodology Summary)	Reasonable estimates based on actual measurements, extrapolation, and reasonable assumptions.	20%	6%	1.1%